

This Page Is Inserted by IFW Operations
and is not a part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

**As rescanning documents *will not* correct images,
please do not report the images to the
Image Problem Mailbox.**

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner
 US Department of Commerce
 United States Patent and Trademark
 Office, PCT
 2011 South Clark Place Room
 CP2/5C24
 Arlington, VA 22202
 ETATS-UNIS D'AMERIQUE
 in its capacity as elected Office

Date of mailing (day/month/year) 21 August 2001 (21.08.01)	
International application No. PCT/SE00/02469	Applicant's or agent's file reference 110008501
International filing date (day/month/year) 08 December 2000 (08.12.00)	Priority date (day/month/year) 09 December 1999 (09.12.99)
Applicant LUNDSTRÖM, Christer et al	

1. The designated Office is hereby notified of its election made:



in the demand filed with the International Preliminary Examining Authority on:

26 June 2001 (26.06.01)



in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was

was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Nestor Santesso Telephone No.: (41-22) 338.83.38
--	--

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

REC'D 09 NOV 2001

WIPO

PCT

Applicant's or agent's file reference 110008501	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/SE00/02469	International filing date (<i>day/month/year</i>) 08-12-2000	Priority date (<i>day/month/year</i>) 09-12-1999
International Patent Classification (IPC) or national classification and IPC ₇ B25J 19/00		
Applicant ABB AB et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 4 sheets, including this cover sheet.
- ☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of _____ sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 26-06-2001	Date of completion of this report 29-10-2001
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88	Authorized officer Ender Dag/itw Telephone No. 08-782 25 00

I. Basis of the report

1. With regard to the elements of the international application:*

- ☒ the international application as originally filed
- ☐ the description:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____
- ☐ the claims:
pages _____, as originally filed
pages _____, as amended (together with any statement) under article 19
pages _____, filed with the demand
pages _____, filed with the letter of _____
- ☐ the drawings:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____
- ☐ the sequence listing part of the description:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language english which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☒ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheet/fig _____

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item I and annexed to this report.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/SE00/02469

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	<u>1-15</u>	YES
	Claims		NO
Inventive step (IS)	Claims	<u>1-15</u>	YES
	Claims		NO
Industrial applicability (IA)	Claims	<u>1-15</u>	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

Documents cited in the International Search Report

D1: EP 0 947 296 A2
D2: JP 1 022 58 91 A
D3: US 4 592 697 A

Document D1 discloses a spring balance apparatus that is located between a base and an arm of a robot. The apparatus is provided in order to counterbalance or reduce fluctuations in gravitational load. The apparatus comprises a rod that is continually urged to plunge into a pipe. A bush housing is an auxiliary member for maintaining the linear motion of the rod. The bush housing guides the rod in linear motion (see column 1, line 30-46; fig 1 and 3).

Document D2 discloses a balance mechanism for multi-joint type industrial robot. A compression plate inside a case has a through hole likewise penetrated by a rod and can move between the case lower end and the rod step. A coil spring is situated between the plate and the case lower end (see abstract).

Document D3 discloses gravity balancing device for robot rocking arm. The device is using compression spring to apply counterbalancing tension force between fixed and arbitrary point on arm (see abstract, fig. 4).

The invention according to claims 1-15 differs from what is known in D1, D2 and D3 by a balancing arrangement in the form of a helical spring based telescopic unit. The telescopic unit comprises more than two telescopic parts involving a pull rod together with a guide tube.

... /...

Supplemental Box

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: V

The unit is arranged between the robot parts and constitutes a support and a guide for the helical spring. The teaching of the prior art as disclosed in the cited documents does not lead a skilled person to the invention. Therefore, the invention defined in the claims is not obvious to a person skilled in the art.

The invention according to claims 1-15 is thus novel and is considered to involve an inventive step. The invention also has industrial applicability.



REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No.

/SE 00 / 0 2 4 6 9

International Filing Date

08 -12- 2000

The Swedish Patent Office
PCT International Application

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference

(if desired) (12 characters maximum)

110008501

Box No. I TITLE OF INVENTION	
Industrial Robot Device	
Box No. II APPLICANT	
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no state of residence is indicated below.)	
ABB AB	
SE-721 83 VÄSTERÅS	
Sweden	
<input type="checkbox"/> This person is also inventor.	
Telephone No.	
Facsimile No.	
Teleprinter No.	
State (that is, country) of nationality:	State (that is, country) of residence:
Sweden	Sweden
This person is applicant for the purposes of: <input type="checkbox"/> all designated States <input checked="" type="checkbox"/> all designated States except the United States of America <input type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box	
Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)	
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no state of residence is indicated below.)	
LUNDSTRÖM, Christer	
Renvägen 4	
SE-745 71 ENKÖPING	
Sweden	
This person is:	
<input type="checkbox"/> applicant only	
<input checked="" type="checkbox"/> applicant and inventor	
<input type="checkbox"/> inventor only (If this check-box is marked, do not fill in below.)	
State (that is, country) of nationality:	State (that is, country) of residence:
Sweden	Sweden
This person is applicant for the purposes of: <input type="checkbox"/> all designated States <input type="checkbox"/> all designated States except the United States of America <input checked="" type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box	
<input checked="" type="checkbox"/> Further applicants and/or (further) inventors are indicated on a continuation sheet.	
Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE	
The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	
<input checked="" type="checkbox"/> agent <input type="checkbox"/> common representative	
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)	
FORSSÉN, Catarina	
AB STOCKHOLMS PATENTBYRÅ, Zacco & Bruhn	
Box 23101, SE-104 35 STOCKHOLM, Sweden	
Telephone No.	
+46 8 729 95 00	
Facsimile No.	
+46 8 31 83 15	
Teleprinter No.	
<input type="checkbox"/> Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.	

Continuation of Box No. III		FURTHER APPLICANTS AND/OR (FURTHER) INVENTORS	
<i>If none of the following sub-boxes is used, this sheet is not to be included in the request.</i>			
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no state of residence is indicated below.) <div style="text-align: center;"> NISSFOLK, Rafael Bandygatan 24 SE-722 40 VÄSTERÅS Sweden </div>		This person is: <input type="checkbox"/> applicant only <input checked="" type="checkbox"/> applicant and inventor <input type="checkbox"/> inventor only (If this check-box is marked, do not fill in below.)	
State (i.e. country) of nationality: Sweden	State (i.e. country) of residence: Sweden		
This person is applicant for the purposes of: <input type="checkbox"/> all designated States <input type="checkbox"/> all designated States except the United States of America <input checked="" type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box			
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no state of residence is indicated below.)		This person is: <input type="checkbox"/> applicant only <input type="checkbox"/> applicant and inventor <input type="checkbox"/> inventor only (If this check-box is marked, do not fill in below.)	
State (i.e. country) of nationality:	State (i.e. country) of residence:		
This person is applicant for the purposes of: <input type="checkbox"/> all designated States <input type="checkbox"/> all designated States except the United States of America <input type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box			
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no state of residence is indicated below.)		This person is: <input type="checkbox"/> applicant only <input type="checkbox"/> applicant and inventor <input type="checkbox"/> inventor only (If this check-box is marked, do not fill in below.)	
State (i.e. country) of nationality:	State (i.e. country) of residence:		
This person is applicant for the purposes of: <input type="checkbox"/> all designated States <input type="checkbox"/> all designated States except the United States of America <input type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box			
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no state of residence is indicated below.)		This person is: <input type="checkbox"/> applicant only <input type="checkbox"/> applicant and inventor <input type="checkbox"/> inventor only (If this check-box is marked, do not fill in below.)	
State (i.e. country) of nationality:	State (i.e. country) of residence:		
This person is applicant for the purposes of: <input type="checkbox"/> all designated States <input type="checkbox"/> all designated States except the United States of America <input type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box			
<input type="checkbox"/> Further applicants and/or (further) inventors are indicated on another continuation sheet.			

Box No.V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) (mark the applicable check-boxes; at least one must be marked):

Regional Patent

- ☒ **AP** ARIPO Patent: GH Ghana, GM Gambia, KE Kenya, LS Lesotho, MW Malawi, MZ Mozambique, SD Sudan, SL Sierra Leone, SZ Swaziland, TZ United Republic of Tanzania, UG Uganda, ZW Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT
- ☒ **EA** Eurasian Patent: AM Armenia, AZ Azerbaijan, BY Belarus, KG Kyrgyzstan, KZ Kazakhstan, MD Republic of Moldova, RU Russian Federation, TJ Tajikistan, TM Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT
- ☒ **EP** European Patent: AT Austria, BE Belgium, CH and LI Switzerland and Liechtenstein, CY Cyprus, DE Germany, DK Denmark, ES Spain, FI Finland, FR France, GB United Kingdom, GR Greece, IE Ireland, IT Italy, LU Luxembourg, MC Monaco, NL Netherlands, PT Portugal, SE Sweden, TR Turkey and any other State which is a Contracting State of the European Patent Convention and of the PCT
- ☒ **OA** OAPI Patent: BF Burkina Faso, BJ Benin, CF Central African Republic, CG Congo, CI Côte d'Ivoire, CM Cameroon, GA Gabon, GN Guinea, GW Guinea-Bissau, ML Mali, MR Mauritania, NE Niger, SN Senegal, TD Chad, TG Togo, and any other State which is a member State of OAPI and a Contracting State of the FCT (if other kind of protection or treatment desired, specify on dotted line).....

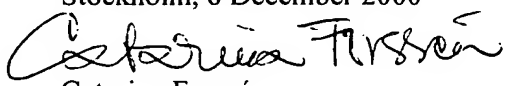
National Patent (if other kind of protection or treatment desired, specify on dotted line):

- | | |
|---|---|
| <input checked="" type="checkbox"/> AE United Arab Emirates | <input checked="" type="checkbox"/> LS Lesotho |
| <input checked="" type="checkbox"/> AG Antigua and Barbuda | <input checked="" type="checkbox"/> LT Lithuania |
| <input checked="" type="checkbox"/> AL Albania | <input checked="" type="checkbox"/> LU Luxembourg |
| <input checked="" type="checkbox"/> AM Armenia | <input checked="" type="checkbox"/> LV Latvia |
| <input checked="" type="checkbox"/> AT Austria | <input checked="" type="checkbox"/> MA Morocco |
| <input checked="" type="checkbox"/> AU Australia | <input checked="" type="checkbox"/> MD Republic of Moldova |
| <input checked="" type="checkbox"/> AZ Azerbaijan | <input checked="" type="checkbox"/> MG Madagascar |
| <input checked="" type="checkbox"/> BA Bosnia and Herzegovina | <input checked="" type="checkbox"/> MK The former Yugoslav Republic of Macedonia |
| <input checked="" type="checkbox"/> BB Barbados | <input checked="" type="checkbox"/> MN Mongolia |
| <input checked="" type="checkbox"/> BG Bulgaria | <input checked="" type="checkbox"/> MW Malawi |
| <input checked="" type="checkbox"/> BR Brazil | <input checked="" type="checkbox"/> MX Mexico |
| <input checked="" type="checkbox"/> BY Belarus | <input checked="" type="checkbox"/> MZ Mozambique |
| <input checked="" type="checkbox"/> CA Canada | <input checked="" type="checkbox"/> NO Norway |
| <input checked="" type="checkbox"/> CH and LI Switzerland and Liechtenstein | <input checked="" type="checkbox"/> NZ New Zealand |
| <input checked="" type="checkbox"/> CN China | <input checked="" type="checkbox"/> PL Poland |
| <input checked="" type="checkbox"/> CR Costa Rica | <input checked="" type="checkbox"/> PT Portugal |
| <input checked="" type="checkbox"/> CU Cuba | <input checked="" type="checkbox"/> RO Romania |
| <input checked="" type="checkbox"/> CZ Czech Republic | <input checked="" type="checkbox"/> RU Russian Federation |
| <input checked="" type="checkbox"/> DE Germany | <input checked="" type="checkbox"/> SD Sudan |
| <input checked="" type="checkbox"/> DK Denmark | <input checked="" type="checkbox"/> SE Sweden |
| <input checked="" type="checkbox"/> DM Dominica | <input checked="" type="checkbox"/> SG Singapore |
| <input checked="" type="checkbox"/> DZ Algeria | <input checked="" type="checkbox"/> SI Slovenia |
| <input checked="" type="checkbox"/> EE Estonia | <input checked="" type="checkbox"/> SK Slovakia |
| <input checked="" type="checkbox"/> ES Spain | <input checked="" type="checkbox"/> SL Sierra Leone |
| <input checked="" type="checkbox"/> FI Finland | <input checked="" type="checkbox"/> TJ Tajikistan |
| <input checked="" type="checkbox"/> GB United Kingdom | <input checked="" type="checkbox"/> TM Turkmenistan |
| <input checked="" type="checkbox"/> GD Grenada | <input checked="" type="checkbox"/> TR Turkey |
| <input checked="" type="checkbox"/> GE Georgia | <input checked="" type="checkbox"/> TT Trinidad and Tobago |
| <input checked="" type="checkbox"/> GH Ghana | <input checked="" type="checkbox"/> TZ Tanzania |
| <input checked="" type="checkbox"/> GM Gambia | <input checked="" type="checkbox"/> UA Ukraine |
| <input checked="" type="checkbox"/> HR Croatia | <input checked="" type="checkbox"/> UG Uganda |
| <input checked="" type="checkbox"/> HU Hungary | <input checked="" type="checkbox"/> US United States of America |
| <input checked="" type="checkbox"/> ID Indonesia | <input checked="" type="checkbox"/> UZ Uzbekistan |
| <input checked="" type="checkbox"/> IL Israel | <input checked="" type="checkbox"/> VN Viet Nam |
| <input checked="" type="checkbox"/> IN India | <input checked="" type="checkbox"/> YU Yugoslavia |
| <input checked="" type="checkbox"/> IS Iceland | <input checked="" type="checkbox"/> ZA South Africa |
| <input checked="" type="checkbox"/> JP Japan | <input checked="" type="checkbox"/> ZW Zimbabwe |
| <input checked="" type="checkbox"/> KE Kenya | |
| <input checked="" type="checkbox"/> KG Kyrgyzstan | |
| <input checked="" type="checkbox"/> KP Democratic People's Republic of Korea | |
| <input checked="" type="checkbox"/> KR Republic of Korea | |
| <input checked="" type="checkbox"/> KZ Kazakhstan | |
| <input checked="" type="checkbox"/> LC Saint Lucia | |
| <input checked="" type="checkbox"/> LK Sri Lanka | |
| <input checked="" type="checkbox"/> LR Liberia | |

Check-boxes reserved for designating States (for the purposes of a national patent) which have become party to the PCT after Issuance of this sheet:

- ☒ **BZ** Belize
- ☐
- ☐
- ☐

Precautionary Designation Statement: In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. (Confirmation of a designation consists of the filing of a notice specifying that designation and the payment of the designation and confirmation fees. Confirmation must reach the receiving Office within the 15-month time limit.)

Box No. VI PRIORITY CLAIM		<input type="checkbox"/> Further priority claim indicated in the Supplemental Box.		
Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is:		
		national application: country	regional application: * regional Office	international application: receiving Office
item (1) 9/12/99 9 December 1999	9904500-7	SE		
item (2)				
item (3)				
<input checked="" type="checkbox"/> The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) (only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office) identified above as item(s): (1)				
* Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See Supplemental Box.				
Box No. VII INTERNATIONAL SEARCHING AUTHORITY				
Choice of International Searching Authority (ISA) (if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):		Request to use results of earlier search; reference to that search (if an earlier search has been carried out by or requested from the International Searching Authority):		
ISA /SE		Date (day/month/year)	Number	Country (or regional Office)
		9/12/99	99/01636	SE
Box No. VIII CHECK LIST; LANGUAGE OF FILING				
This international application contains the following number of sheets:		This international application is accompanied by the item(s) marked below:		
request	:5 ✓	1. <input checked="" type="checkbox"/> fee calculation sheet		
description (excluding sequence listing part)	:7 ✓	2. <input checked="" type="checkbox"/> separate signed power of attorney		
claims	:2 ✓	3. <input checked="" type="checkbox"/> copy of general power of attorney; reference number, if any: PGF 3425/2000		
abstract	:1 ✓	4. <input type="checkbox"/> statement explaining lack of signature		
drawings	:5 ✓	5. <input type="checkbox"/> priority document(s) identified in Box No VI as item(s):		
sequence listing part of description	:	6. <input type="checkbox"/> translation of international application into (language):		
Total number of sheets:	20 ✓	7. <input type="checkbox"/> separate indications concerning deposited microorganism or other biological material		
		8. <input type="checkbox"/> nucleotide and/or amino acid sequence listing in computer readable form		
		9. <input checked="" type="checkbox"/> other (specify): List of representatives, copy of ITS		
Figure of the drawings which should accompany the abstract: Fig. 1		Language of filing of the international application: Swedish		
Box No. IX SIGNATURE OF APPLICANT OR AGENT				
Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).				
Stockholm, 8 December 2000				
				
Catarina Forssén Representative of the applicant				

For receiving Office use only		08 -12- 2000	
1. Date of actual receipt of the purported international application:	2. Drawings:		
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:	<input checked="" type="checkbox"/> received:		
4. Date of timely receipt of the required corrections under PCT Article 11(2):	<input type="checkbox"/> not received:		
5. International Searching Authority (if two or more are competent): ISA / SE	<input type="checkbox"/> 6. Transmittal of search copy delayed until search fee is paid		

For International Bureau use only	
Date of receipt of the record copy by the International Bureau:	17 JANUARY 2001
(17. 01. 01)	
Form PCT/RO/101 (last sheet)	
See Notes to the request form	

Supplemental box*If the Supplemental Box is not used, this sheet should not be included in the request.*

1. *If, in any of the Boxes, the space is insufficient to furnish all the information: in such case, write "Continuation of Box No. ..." (indicate the number of the Box) and furnish the information in the same manner as required according to the captions of the Box in which the space was insufficient, in particular.*
 - (i) *If more than two persons are involved as applicants and/or inventors and no "continuation sheet" is available: in such case, write "Continuation of Box No. III" and indicate for each additional person the same type of information as required in Box No. III. The country of the address indicated in this Box is the applicant's State (that is country) of residence if no State of residence is indicated below:*
 - (ii) *If, in Box No. II or in any of the sub-boxes of Box No. III, the indication "the States indicated in the Supplemental Box" is checked: in such case, write "Continuation of Box No. II" or "Continuation of Box No. III" or "Continuation of Boxes No. II and No. III" (as the case may be), indicate the name of the applicant(s) involved and, next to (each) such name, the State(s) (and/or, where applicable, ARIPO, Eurasian, European or OAPI patent) for the purposes of which the named person is applicant:*
 - (iii) *If, in Box No. II or in any of the sub-boxes of Box No. III, the inventor or the inventor/applicant is not inventor for the purposes of all designated States or for the purposes of the United States of America: in such case, write "Continuation of Box No. II" or "Continuation of Box No. III" or "Continuation of Boxes No. II and No. III" (as the case may be), indicated the name of the inventor(s) and, next to (each) such name, the State(s) (and/or, where applicable, ARIPO, Eurasian, European or OAPI patent) for the purposes of which the named person is inventor:*
 - (iv) *If, in addition to the agent(s) indicated in Box No. IV, there are further agents: in such case, write "Continuation of Box No. IV" and indicate for each further agent the same type of information as required in Box No. IV;*
 - (v) *If, in Box No. V, the name of any State (or OAPI) is accompanied by the indication "patent addition" or "certificate of addition" or if, in Box No. V, the name of the United States of America is accompanied by an indication "continuation" or "continuation-in-part": in such case, write "Continuation of Box No. V" and the name of each State involved (or OAPI), and after the name of each such State (or OAPI), the number of the parent title or parent application and the date of grant of the parent title or filing of the parent application:*
 - (vi) *If, in Box No. VI, there are more than three earlier applications whose priority is claimed: in such case, write "Continuation of Box No. VI" and indicated for each additional earlier application the same type of information as required in Box No. VI:*
 - (vii) *If, in Box No. VI, the earlier application is an ARIPO application: in such case, write "Continuation of Box No. VI", specify the number of the item corresponding to that earlier application and indicate at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed.*
2. *If, with regard to the precautionary designation statement contained in Box No. V, the applicant wishes to exclude any State(s) from the scope of that statement: in such case, write "Designation(s) excluded from precautionary designation statement" and indicate the name or two-letter code of each State so excluded.*
3. *If the applicant claims, in respect of any designated Office, the benefits of provisions of the national law concerning non-prejudicial disclosures of exceptions to lack of novelty: in such case, write "Statement concerning non-prejudicial disclosures or exceptions to lack of novelty" and furnish that statement below.*

CONTINUATION OF BOX IV:

Further representatives:

Agvald-Glas, Gunilla
 Bernhult, Lennart
 Forssén, Catarina
 Grahn, Cecilia
 Granström, Lars-Eric
 Grip, Joakim
 Hansson, Hans-Erik
 Hansson, Sven A.
 Hinz, Udo
 Karlsson, Per Tomas
 Lennefors, Stefan
 Lundström, Maria
 Nilsson, Brita
 Nordén, J. Åke
 Onn, Thorsten
 Rilton, Kristina
 Westerlund, Örjan
 Åström, Elsa

1/5

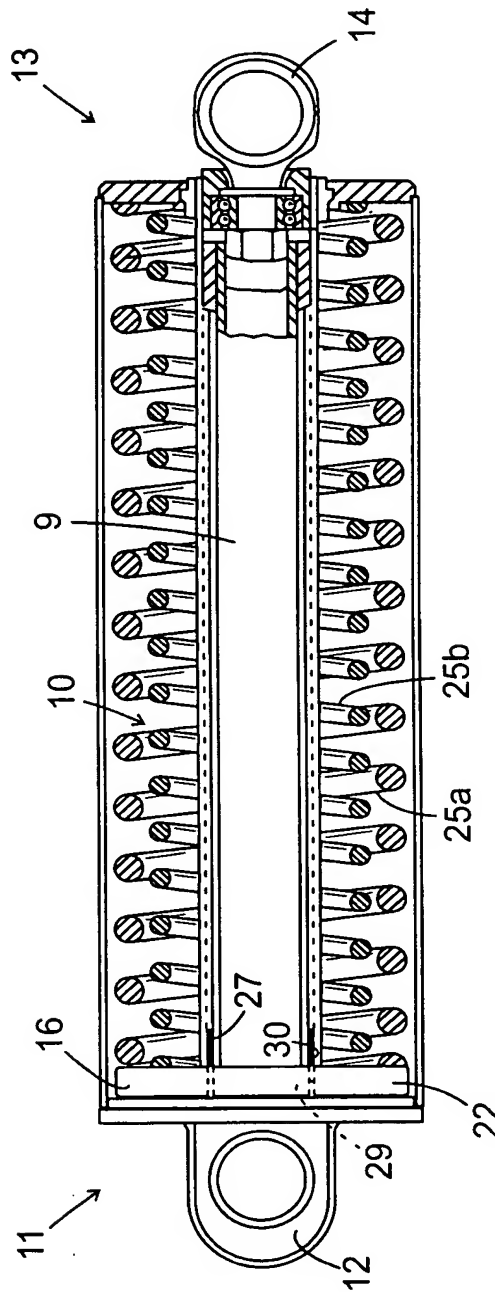


FIG.1

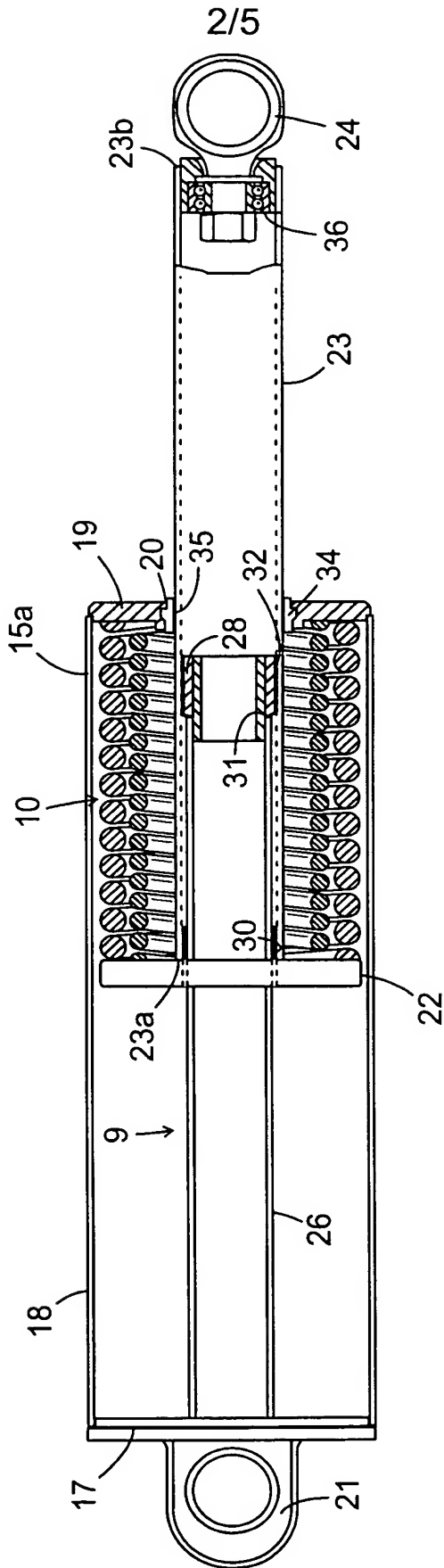


FIG. 2

3/5

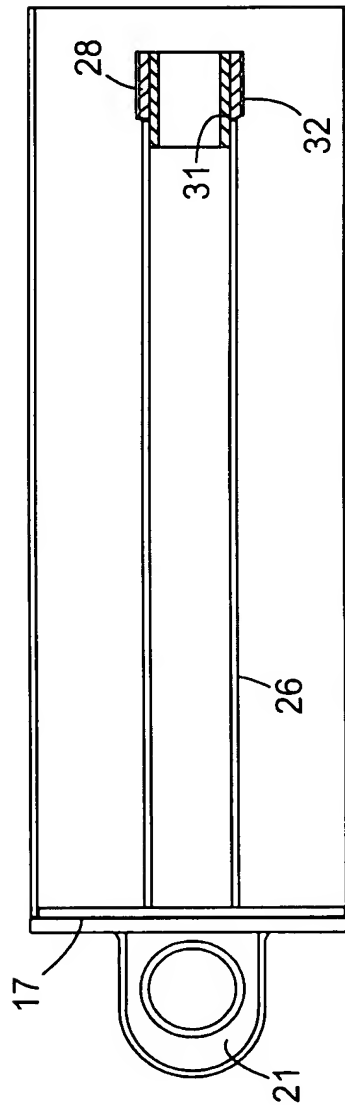


FIG.3

4/5

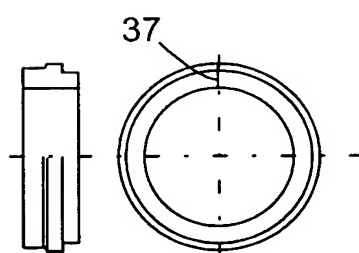
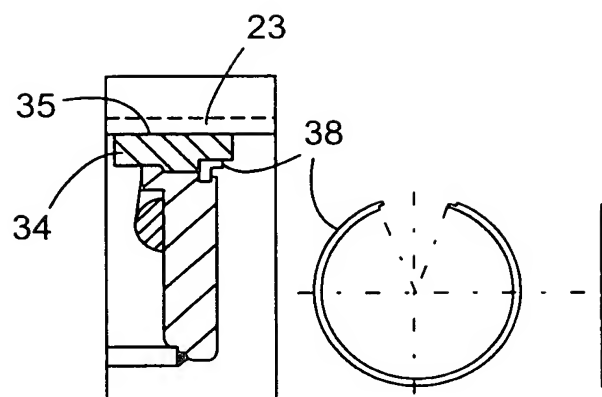


FIG.4

5/5

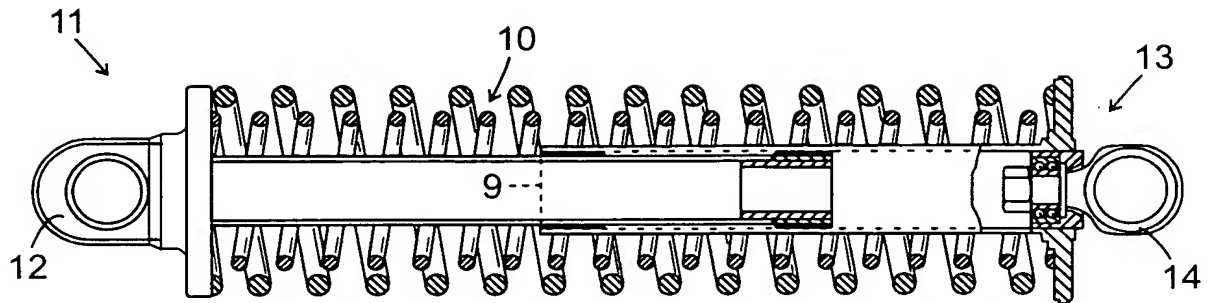


FIG. 5

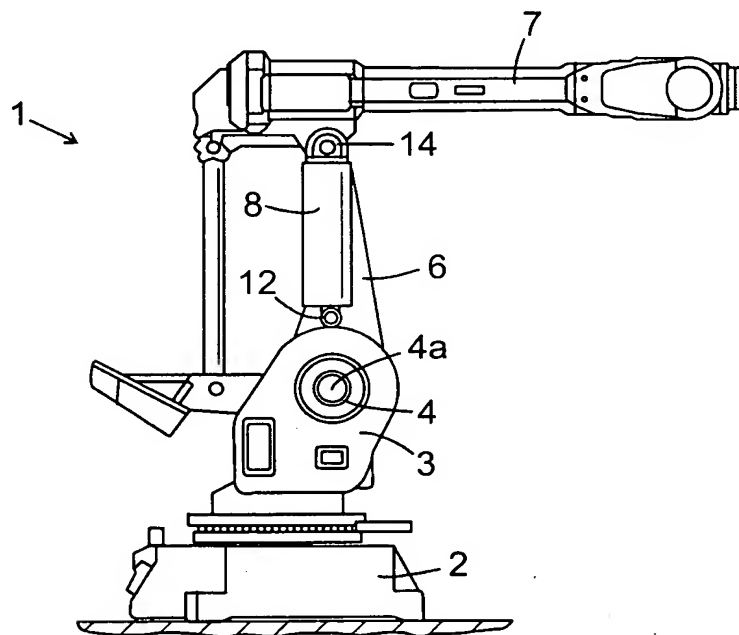


FIG. 6

KN 8747 SE/JS

2000-12-08

5 Anordning vid industrirobot

TEKNISKT OMRÅDE

Föreliggande uppfinning hänför sig till en industrirobot med en skruvfjäderuppbyggd balanseringsanordning, samt förfarande för och användning av roboten.

10

BAKGRUND

I industrirobotar innefattande två robotdelar vridbart anordnade i förhållande till varandra krävs starka strömkrävande motorer, som utför vridningen av roboten. Starka strömkrävande motorer är stora, tunga och dyra, vilket leder till behov av alternativa lösningar. Ett alternativ
15 är att komplettera roboten med en anordning, som vid vridning av roboten är delaktig i vridningen genom att den tar upp ett vridmoment under vridningen från ett viloläge/utgångsläge dvs. när roboten börjar en arbetscykel. Med begreppet vridning från ett viloläge / utgångsläge avses här en vridning i en riktning där gravitationskraften bidrar till vridningen. Anordningen är så beskaffad att den under vridningen från viloläget alstrar ett
20 vridmoment, vilket verkar för att återföra roboten till dess viloläge / utgångsläge och hjälper / avlastar därmed berörd drivmotor vid lyftning / vridning tillbaka. Begreppet vridning tillbaka till viloläget / utgångsläget avser därmed en vridning som motverkar och därmed kompenserar för gravitationskraften, vilken vridning benämns balansering i det följande. Anordningen enligt ovan anses därmed vara en balanseringsanordning.

25

Genom att anordna industrirobotar med balanseringanordningar, som hjälper och avlastar drivmotorerna, tvingas inte robottillverkaren att installera onödigt stora och kraftfulla motorer i roboten. Omvänt gäller även, en kraftfull drivmotor i kombination med en kraftig balanseringsanordning ökar en stor industrirobots lyftkapacitet i handleden. Det medför
30 emellertid en ökad egenvikt hos både motor och balanseringsanordning, vilket i sin tur ställer ännu större krav på berörd drivmotor.

En balanseringsanordning hjälper således berörd motor att balansera ut dels pålagd hanteringsvikt och dels den för roboten aktuella egenvikten när vridning sker vid drift av

roboten. Balanseringsanordningar utgörs generellt av vikter, gashydrauliska anordningar eller fjäderanordningar i form av skruvfjäder-, torsionsfjäder- och / eller gas-uppbyggda balanseringscylindrar. Frånsett motvikterna är de ovan nämnda anordningarna dyra, tunga och känsliga konstruktioner. Gashydrauliska anordningar är utrymmeskrävande och dessutom behäftade med täthetsproblem.

Vid skruvfjäderuppbyggda balanseringscylindrar finns alltid risk för snedställning av kolvstången i förhållande till cylindern s.k. byrålådseffekt, vilken när den uppstår medför att cylinderanordningen slits och dess livslängd förkortas drastiskt. Även alternativet motvikter för nackdelar med sig, eftersom en robot med motvikt inte kan utformas lika kompakt och utrymmessnål. Motvikten hindrar dessutom robotens rörelsemöjlighet.

När roboten gör alltför begränsade rörelsecykler, dvs roboten rör sig för lite, uppstår problem med dålig smörjning i de ingående lagren.

Det japanska patentet JP 10015874 visar en robot anordnad med en gravitations-kompenserande fjäderanordning. Anordningen innefattar ett fjäderhus, vilket innehåller en skruvfjäder, ett fjädersäte och en dragstång kopplad till fjädersätet. Tre styrpinnar är anordnade genom varsitt hål i fjädersätet, vilket glider längs styrpinnarna när dragstången dras ut och skruvfjädern därmed trycks ihop. Syftet är att förhindra skador på dragstången.

Industrirobotar består vanligen av en robotföt, stativ och robotarm. Stativet är roterbart anordnat på robotfoten. Robotarmen är vridbart anordnad i en led på stativet. Robotarmen består av armdelar vridbart anordnade i förhållande till varandra. Robotens arm innefattar exempelvis en första och en andra armdel samt en handled anordnad med ett verktygsfäste. Armen är i sitt utgångsläge / viloläge orienterad med den första armdelen i det närmaste vertikalt. När roboten rör sig / arbetar vrids armen i förhållande till stativet samtidigt som armdelarna vrids i förhållande till varandra. Den totala belastningen på roboten utgörs av dels pålagd hanteringsvikt i handleden och dels robotens aktuella egenvikt. Vid vridning vrider berörd motor robotarmen varvid den på armen verkande gravitationskraften belastar / påverkar balanseringsanordningen varvid balanseringsanordningen alstrar ett vridmoment.

Balanseringsanordningen underlättar sedan för motorn att vrida armen tillbaka till utgångsläge / viloläge. Berörd vridmotor ska sålunda, vid vridning av roboten tillbaka, klara av att hantera ett resterande vridmoment, vilket utgör summan av dels momentet från robotens totala belastning och dels det i balanseringsanordningens alstrade motriktade vridmoment.

Balanseringsanordningens alstrade vridmoment och berörd vridmotors styrka är därmed i beroendeförhållande.

5 Utvecklingen av industrirobotar går mot större och större robotar. För cirka 10 år sedan klarade stora robotar att lyfta upp till 100 kg i handleden. Den vidare utvecklingen har möjliggjort lyft på 200 kg och nu finns behovet av att öka lyftkapaciteten i handleden till extremt höga belastningar på omkring 250 kg. Vid så stora belastningar i handleden är det oerhört viktigt att en balanseringsanordning arbetar på rätt sätt.

10 Vid balanseringsanordningar innefattande skruvfjädrar blir skruvfjädern hoptryckt respektive utdragen. Vid en hoptryckt skruvfjäder finns alltid risken att den böjs ut åt sidan d.v.s. viker sig / knäcks. Därmed finns behovet att förhindra att skruvfjädern viker sig.

15 Vid belastningar av roboten på upp mot 250 kg i handleden tvingas en balanseringsanordning att arbeta med mycket stora momentkrafter och tar lätt skada. Skadorna uppstår vanligen genom att balanseringsanordningen snedbelastas. I fallet med en skruvfjäder, fjäderhus, fjädersäte och en dragstång leder en snedbelastning av dragstången, s.k. byrålådseffekt, till en snedställning av dragstången i fjäderhuset, slitage uppstår och balanseringsanordningens livslängd reduceras till en oacceptabelt låg nivå. Detta medför oönskade och fördyrande driftsstopp vid produktion. Dessutom tillkommer oönskade extra kostnader för reservdelar.

20 I anordningen enligt det ovannämnda japanska patentet kan fjädersätet inte vrida sig axiellt i fjäderhuset. Vid belastning uppstår stora böjmoment i dragstångsdelen i fjäderhuset, vilket medför mycket stora påkänningar i konstruktionen, höga yttryck alstras och detta sammantaget resulterar i att dragstången böjer ut.

25 Vid tillverkning av industrirobotar av ovan angivet slag uppkommer därmed behov av en balanseringsanordning, vilken klarar extremt höga belastningar på upp till 250 kg och samtidigt har lika lång livslängd som industriroboten. Därmed elimineras oönskade driftsstopp och behov av reservdelar.

30 Dessa behov kan inte balanseringsanordningen enligt det ovannämnda japanska patentet uppfylla.

REDOGÖRELSE FÖR UPPFINNINGEN

En industrirobot, innefattande en manipulator med styrsystem, uppvisar robotfot, stativ och robotarm med handled och verktyg. Stativet är roterbart anordnat på robotfoten. Robotarmen är vridbart anordnad på stativet i en led. Robotarmen består av åtminstone en första och en andra armdel samt handleden, vilka är vridbart anordnade i förhållande till varandra. En
5 balanseringsanordning är anordnad för att vid vridning av roboten utöva en dragkraft mellan en första och en andra robotdel och därmed motverka / balansera gravitationskraften när robotdelarnas inbördes lägesförhållande förändras. Balanseringsanordningen är fäst på resp robotdel med infästningsorgan.

10 Syftet med uppfinningen är att på en robot enligt ovan anordna en skruvfjäderuppbyggd balanseringsanordning, där roboten klarar att lyfta 250 kg i handleden utan att balanseringsanordningen tar skada. Vidare är syftet med uppfinningen att förse roboten med en balanseringsanordning, vilken har lika lång livslängd som roboten. Uppgiften för uppfinningen är således att i en balanseringsanordning enligt ovan förbättra styrningen av en
15 dragstång i ett fjäderhus och därmed eliminera risken för snedställning av dragstången s.k. byråldseffekt.

Lösningen enligt uppfinningen kännetecknas av den i patentkrav 1 angivna anordningen med en balanseringsanordning i form av en skruvfjäderuppbyggd teleskopisk enhet. En dragstång
20 bildar tillsammans med ett styrrör en teleskopisk enhet, vilken är anordnad mellan robotdelarna och utgör ett stöd och en styrning för skruvfjädern. Vid vridning av roboten förlängs alternativt förkortas den teleskopiska enheten samtidigt som styrningen av dragstången förbättras i enlighet med det självständiga förfarandekravet. Vidare förhindrar uppfinningen att vridkrafter från skruvfjädern /-fjädrarna fortplantas till den teleskopiska
25 enheten, genom att dragstången kan vrida sig fritt kring sin längdaxel, i enlighet med de underordnade kraven. En robot enligt uppfinningen kan utrustas med en eller flera balanseringsanordningar och vara anordnad med företrädesvis en vertikalt ledad robotarm i enlighet med det självständiga användningskravet.

30 Det ingår i uppfinningstanken att den teleskopiska enheten innefattar mer än två teleskopiska delar.

Det ingår i uppfinningstanken att balanseringsanordningen enligt uppfinningen är anordnad mellan armdelar hos roboten, vilka inte är direkt anslutna till varandra.

Det ingår i uppfinningstanken att roboten är takmonterad eller vinklat monterad.

Det ingår även i uppfinningstanken att en robot är anordnad så att balanseringsanordningen är utformad med fjädersäten, vilka är fast anordnade vid balanseringsanordningens respektive fästen och att den teleskopiska enheten sträcker sig koaxiellt genom fjädersatsen. Vid vridning av roboten dras både den teleskopiska enheten och skruvfjäderenheten ut i längdled.

I lösningen enligt uppfinningen ingår även att roboten är utrustad med en eller flera balanseringsanordningar.

10

Det ingår i uppfinningstanken att fjäderhuset är försett med lufthål för att eliminera pumpning vid kolvens rörelse fram och tillbaka.

Det ingår även i uppfinningstanken att ett fästöra är anordnat roterbart via ett rullningslager.

15

Det ingår i uppfinningstanken att den beskrivna kolven är ersatt med någon annan form av fjädersäte.

Det ingår i uppfinningstanken att dragstången är en kolvstång.

20

FIGURBESKRIVNING

Uppfinningen kommer att förklaras närmare genom beskrivning av ett utföringsexempel under hänvisning till bifogade ritning, där

25 Fig 1 visar en balanseringsanordning enligt föreliggande uppfinning med dragstången indragen.

Fig 2 visar en balanseringsanordning enligt fig 1 med utdragen dragstång.

Fig 3 visar en balanseringsanordning enligt fig 1 utan skruvfjäder och dragstång.

Fig 4 visar en styrning anordnad i en fjäderhusöppning.

30 Fig 5 visar en alternativ utformning av uppfinningen.

Fig 6 visar en industrirobot försedd med en balanseringsanordning enligt uppfinningen.

BESKRIVNING AV UTFÖRINGSEXEMPEL

En industrirobot 1 (fig. 6) innefattar en robotfot 2, ett på robotfoten 2 roterbart anordnat stativ 3 och en i en led 4 på stativet 3 förbunden robotarm 5, vilken innefattar en första och en andra armdel 6 resp. 7. Robotarmen 5 vrids kring en horisontell vridningsaxel 4a i leden 4. En balanseringsanordning 8, innefattande en teleskopisk enhet 9 och en skruvfjäderenhet 10, är monterad på roboten 1 (fig. 1). Skruvfjäderenheten 10 är koaxiellt anordnad på den teleskopiska enheten 9. Balanseringsanordningen 8 innefattar i sin första ände 11 ett första fäste 12 för ledad infästning till stativet 3 och i sin andra ände 13 ett andra fäste 14 för ledad infästning till första armdelen 6.

10

Den teleskopiska enheten 9 innefattar ett första fjädersäte 15 och ett andra fjädersäte 16 mellan vilka skruvfjäderenheten 10 är anordnad (fig 2). Det första fjädersätet 15 innefattar ett fjäderhus 15a, vilket är anordnat med en första gavel 17, en cylindrisk mantelyta 18 samt en andra gavel 19, försedd med en öppning 20. Ett fäste 12 i form av ett första fästöra 21 är anordnat på utsidan av den första gaveln 17. Det andra fjädersätet 16 innefattar en kolv 22, vilken är fast anordnad vid första änden 23a av en dragstång 23. Dragstången 23 tillsammans med kolven 22 är i längdled förskjutbart anordnade inuti fjäderhuset 15a. Den rörformade dragstången 23 sträcker sig från kolven 22, genom en del av fjäderhuset 15a och ut genom öppningen 20 i fjäderhusets andra gavel 19. Dragstången 23 är i sin andra ände 23b försedd med ett fäste 14 i form av ett andra fästöra 24. Skruvfjäderenheten 10 innefattar en fjädersats 25 i form av två skruvfjädrar 25a och 25b är anordnade inuti fjäderhuset 15a mellan kolven 22 och fjäderhusets 15a andra gavel 19.

När dragstången dras ut ur fjäderhuset 15a trycks fjädersatsen 25 ihop och alstrar därmed en fjäderkraft, som vill dra ut skruvfjädern och därmed dra dragstången 23 tillbaka in i fjäderhuset 15a. Den alstrade fjäderkraften utnyttjas för balanseringen.

Koaxiellt inuti fjäderhuset 15a är ett styrrör 26 fast anordnat på första gavelns 17 insida. Styrröret 26 sträcker sig inuti fjäderhuset 15a från första gaveln 17 och nästan fram till den andra gaveln 19. Styrröret 26 har således en längd, som understiger fjäderhusets 15a längd. Styrröret 26 har en ytterdiameter, som något understiger den rörformade dragstångens 23 innerdiameter.

När dragstången 23 förskjuts längs styrröret 26 ska dragstången 23 glida med mycket god styrning och minimal friktion längs styrröret 26. Detta åstadkoms genom en första och en

andra bussning 27 resp. 28. Den första bussningen 27 är fast anordnad koaxiellt med och på insidan av dels dragstången 23 och dels en öppning 29 hos fjädersätet 22 för att bilda en i längsled utsträckt sammanhängande första styryta 30 (fig 1). Den andra bussningen 28 är fast anordnad på utsidan av styrrörets 26 fria ände 31, för att hos styrröret 26 bilda en i längsled utsträckt andra styryta 32 (fig 3). Vid förskjutning av dragstången 23 glider fjädersätet 22 längs styrröret 26.

Vid förskjutning av dragstången 23, genom öppningen 20 i gaveln 19, glider dragstången 23 teleskopiskt utanpå styrröret 26, vilka därmed tillsammans utgör en teleskopisk enhet 9. Rörelsen stabiliseras genom att dragstången 23 får stöd av första 30 och andra 32 styrytorna, vilka är anordnade på avstånd från varandra i längdled. Första 30 och andra 32 styrytorna styr med glidpassning dragstången 23, som tillsammans med styrröret 26 bildar en böjstyv enhet 33 mellan första 21 och andra fästörat 24 (fig 2).

I fjäderhusets 15a andra gavel 19 är en styrning 34 fast anordnad i öppningen 20. Styrningen 34 är utformad med en i fjäderhusets 15a i längdled utsträckt tredje styryta 35. Den tredje styrytan 35 styr och glidlagrar dragstången 23 vid dess rörelse ut ur och in i fjäderhuset 15a genom öppningen 20 (fig 2).

De mellan kolven 22 och fjäderhusets andra gavel 19 befintliga skruvfjädrarnas 25a och 25b möjlighet att tryckas ihop avgör, hur långt dragstången 23 kan dras ut ur fjäderhuset 15a. Av figur 2 framgår att styrröret 26 och dragstången 23 är teleskopiskt upptagna i varandra i tillräcklig grad för att ge en exakt styrning och god stadga när dragstången 23 dras ut maximalt. För att säkra att dragstången 23 kan vrida sig fritt i fjäderhuset 15a är det andra fästörat 24 roterbart anordnat i dragstångens andra ände 23b via ett vinkelkullager 36.

Styrningen 34 är lösbart anordnad koaxiellt i gavelns 19 öppning 20 (fig 4). Styrningens 34 uppgift är primärt att via tredje styrytan 35 styra dragstången 23 samt sekundärt att täta eller avgränsa fjäderhuset 15a. Styrningen 34 är anordnad lätt utbytbar. Styrningen 34 har en öppning 37, vilken är uppslitsad utan materialförlust. Den kan således lätt träs på dragstången 23 och föras axiellt till avsedd plats i öppningen 20. En låsring 38 låser styrningen 34 mot axiell förskjutning i öppningen 20.

PATENTKRAV

1. Industrirobot (1) innefattande en första robotdel (3) och en andra robotdel (5) anordnade rörliga i förhållande till varandra och en dem emellan verkande balanseringsanordning (8),
5 varvid balanseringsanordningen (8) innefattar ett första fäste (12) och ett andra fäste (14) för ledad infästning till respektive robotdel (3), (5) och varvid balanseringsanordningen (8) är anordnad att motverka gravitationskraften vid vridning av robotdelarna (3),(5) k ä n n e t e c k n a d a v att balanseringsanordningen (8) innefattar en teleskopisk enhet (9) anslutande till respektive fäste (12),(14) och en skruvfjäderenhet (10) anordnad
10 mellan ett på den teleskopiska enheten (9) fixerade första fjädersäte (15) respektive andra fjädersäte (16).
2. Industrirobot enligt krav 1, k ä n n e t e c k n a d a v att den teleskopiska enheten (9) är anordnad koaxiell med skruvfjäderenheten (10).
15
3. Industrirobot enligt något av kraven 1-2, k ä n n e t e c k n a d a v att den teleskopiska enheten (9) innefattar en dragstång (23) och ett styrrör (26).
4. Industrirobot enligt krav 3, k ä n n e t e c k n a d a v att styrröret (26) innefattar det
20 första fjädersätet (15).
5. Industrirobot enligt krav 3, k ä n n e t e c k n a d a v att dragstången (23) innefattar det andra fjädersätet (16).
- 25 6. Industrirobot enligt något av kraven 1-4, k ä n n e t e c k n a d a v att det första fjädersätet (15) innefattar ett fjäderhus (15a).
7. Industrirobot enligt krav 6, k ä n n e t e c k n a d a v att styrröret (26) är fäst koaxiellt i det skruvfjäderenheten (10) omslutande fjäderhuset (15a).

8. Industrirobot enligt krav 6, k ä n n e t e c k n a d a v att dragstången (23) är förskjutbart anordnad utanpå styrröret (26) och sträcker sig med en första ände (23a) ut genom en öppning (20) i fjäderhuset (15a).

5 9. Industrirobot enligt krav 3, k ä n n e t e c k n a d a v att dragstången (23) är utformad med ett fritt roterbart fäste (12) i sin andra ände (23b).

10. Industrirobot enligt krav 8, k ä n n e t e c k n a d a v att en utbytbar styrring (34) är fixerat anordnad i fjäderhusets (15a) öppning (20).

10

11. Förfarande vid balansering av en industrirobot (1) innefattande en första robotdel (3) och en andra robotdel (6) anordnade rörliga i förhållande till varandra och en dem emellan verkande balanseringsanordning (8), varvid balanseringsanordningen (8) innefattar ett första fäste (12) och ett andra fäste (14) för ledad infästning till respektive robotdel (3),(6) och varvid balanseringsanordningen (8) är anordnad att motverka gravitationskraften vid vridning av robotdelarna (3),(6) k ä n n e t e c k n a t a v att balanseringsanordningen (8) bringas att innefatta en teleskopisk enhet (9) anslutande till respektive fäste (12),(14) och att en skruvfjäderenhets (10) anordnas mellan ett på den teleskopiska enheten (9) fixerade första fjädersäte (15) respektive andra fjädersäte (16).

20

12. Förfarande vid en industrirobot enligt krav 11 k ä n n e t e c k n a t a v att den teleskopiska enheten (9) styr skruvfjäderenhets (10).

13. Förfarande vid en industrirobot enligt något av kraven 11-12 k ä n n e t e c k n a t a v att skruvfjäderenhets (10) anordnas koaxiellt på den teleskopiska enheten.

25

14. Förfarande i enlighet med krav 11 k ä n n e t e c k n a t a v att det andra fästet (14) anbringas i form av ett fritt roterbart fästöra 24.

30

15. Användning av en robot enligt krav 1 och ett förfarande enligt krav 11 anordnad med en vertikalt ledad robotarm.

5

SAMMANDRAG

10 Industrirobot anordnad med ett skruvfjäderuppbyggt balanseringssystem, vilket klarar hög belastning.

(fig 1)

(19) World Intellectual Property Organization
International Bureau



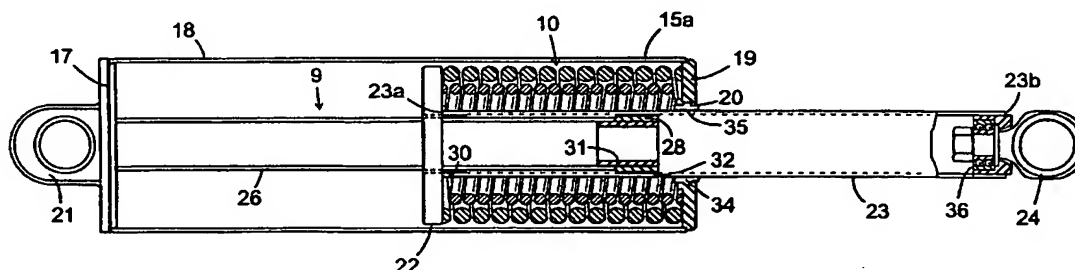
(43) International Publication Date
14 June 2001 (14.06.2001)

PCT

(10) International Publication Number
WO 01/41978 A1

- (51) International Patent Classification⁷: **B25J 19/00**
- (21) International Application Number: **PCT/SE00/02469**
- (22) International Filing Date: 8 December 2000 (08.12.2000)
- (25) Filing Language: **Swedish**
- (26) Publication Language: **English**
- (30) Priority Data:
9904500-7 9 December 1999 (09.12.1999) **SE**
- (71) Applicant (for all designated States except US): **ABB AB**
[SE/SE]; S-721 83 Västerås (SE).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **LUNDSTRÖM, Christer** [SE/SE]; Renvägen 4, S-745 71 Enköping (SE).
NISSFOLK, Rafael [SE/SE]; Bandygatan 24, S-722 40 Västerås (SE).
- (74) Agents: **FORSSÉN, Catarina et al.**; Stockholms Patentbyrå Zacco AB, P.O. Box 23101, S-104 35 Stockholm (SE).
- (81) Designated States (*national*): AE, AG, AL, AM, AT, AT (utility model), AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, CZ (utility model), DE, DE (utility model), DK, DK (utility model), DM, DZ, EE, EE (utility model), ES, FI, FI (utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (utility model), SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.
- (84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).
- Published:
— With international search report.
- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: **INDUSTRIAL ROBOT WITH A BALANCING DEVICE**



(57) Abstract: Industrial robot arranged with a helical spring based balancing system, which is able to stand up to high load.

WO 01/41978 A1

Industrial robot with a balancing device

TECHNICAL FIELD

The present invention relates to an industrial robot with an equalizing device, comprising a
5 helical spring, and a method for balancing and use of the robot.

BACKGROUND

In industrial robots, comprising two robot parts pivotally arranged relative each other, powerful power consuming motors, which execute the pivoting of the robot, are required.
10 Powerful power consuming motors are large, heavy and expensive, which commands a need of alternative solutions. One alternative is to supplement the robot with a device, which in the pivoting of the robot participates in the pivoting by absorbing the torque during the pivoting from a rest position/initial position, i.e. when the robot starts a work cycle. The concept pivoting from a rest position/initial position refers to a pivoting in a direction where the
15 attraction of gravity contributes to the pivoting. The arrangement is of such a nature that it during the pivoting from the rest position generates a torque, which acts to restore the robot to its rest position/initial position and thereby helps/relieves the driving motor concerned during the lifting/pivoting back. The concept pivoting back to the rest position/initial position refers to a pivoting which counteracts and thereby compensates for the attraction of gravity, which
20 pivoting in the following is designated balancing. The arrangement according to the foregoing is thus considered a balancing arrangement.

By arranging industrial robots with balancing arrangements, which help and relieve the driving motors, the robot manufacturer is not forced to install unnecessarily large and
25 powerful motors in the robot. The opposite also applies, a powerful driving motor in combination with a powerful balancing arrangement increases the lifting capacity in the wrist of a large industrial robot. However, this leads to an increase in dead weight of both the motor and the balancing arrangement, which in turn calls for even bigger demands on the driving motor in question.

30

A balancing arrangement thus helps the motor concerned to counterbalance the applied handling weight as well as the present dead weight when pivoting occurs during operation of the robot. Balancing arrangements generally consist of weights, gas-hydraulic devices or

spring devices in the form of helical springs, torsion springs and/or gas-based balancing cylinders. Apart from the counterweights the above mentioned devices are expensive, heavy and sensitive constructions. Gashydraulic devices are space demanding and are furthermore marred by density problems.

- 5 In helical spring-based balancing cylinders there is always a risk for obliquity of the piston rod in relation to the cylinder, the so-called drawer effect, which when it arises leads to wear of the cylinder device and drastically shortened life-time. The alternative with counterweights also results in disadvantages, because a robot with a counterweight can not be as compact and space-saving. The counterweight also restrains the freedom of movement of the robot.
- 10 When the robot performs overly limited motion cycles, i.e. the robot is moving too little, problems with poor lubrication in the integral bearings arise.

The Japanese patent JP 10015874 discloses a robot arranged with a gravitation compensating spring device. The device comprises a spring housing, which includes a helical spring, a
15 spring seat and a pull rod attached to the spring seat. Three guide pins are each arranged through a separate hole in the spring seat, which glides along the guide pins when the pull rod is pulled out and the helical spring by that is compressed. The aim is to prevent damage on the pull rod.

- 20 Industrial robots usually consist of a robot foot, a stand and a robot arm. The stand is rotatably arranged on the robot foot. The robot arm is pivotably arranged in a joint on the stand. The robot arm is composed of arm parts pivotably arranged in relation to each other. The robot arm comprises e.g. a first and a second arm part and also a wrist arranged with a tool attachment. The arm in its initial position/rest position is oriented with the first arm part
25 almost vertical. When the robot is moving/in operation the arm pivots in relation to the stand at the same time as the arm parts pivots in relation to each other.

The total load on the robot consists of the applied handling weight in the wrist on one hand and the present dead weight of the robot on the other. In pivoting, the motor in question pivots the robot arm, and the the gravity acting on the arm loads/influences the balancing
30 arrangement, whereby the balancing arrangement generates a torque.

The balancing arrangement then facilitates for the motor to pivot the arm back to its initial position / rest position. The pivot motor in question must thus, in pivoting the robot back, be able to handle a remaining torque, which is the sum of the moment from the total load as well

as the oppositely directed torque generated in the balancing arrangement. The torque generated by the balancing arrangement and the power of the concerned pivot motor are thus in a state of dependence.

The development of industrial robots is moving towards ever larger robots. 10 years ago large robots managed to lift up to 100 kg with the wrist. The further development has made lifts of 200 kg possible and now there is a need to increase the lifting capacity in the wrist to extremely high loads of approximately 250 kg. With as high loads as that in the wrist, it is immensely important that a balancing arrangement works in the right manner.

In balancing arrangements comprising helical springs the helical spring is compressed or extended. When a helical spring is compressed there is always the risk that it deflects sideways i.e. bends/collapses. It must thus be prevented that the helical spring bends.

With loads on the robot of up to 250 kg in the wrist a balancing arrangement is forced to work with very large torque forces and is easily damaged. The damages usually originate through imbalance in the load of the balancing arrangement. In the case with a helical spring, spring housing, spring seat and a pull rod an imbalance in the load of the pull rod, so-called drawer effect, leads to obliquity of the pull rod in the spring housing, wear appears and the expected life-time of the balancing arrangement is reduced to an unacceptably low level. This leads to unwanted and expensive production interruptions. Furthermore there will also be extra unwanted cost for spare equipment.

In the arrangement according to the above mentioned Japanese patent the spring seat cannot turn axially in the spring housing. Load leads to large bending moments in the pull rod part in the spring housing, which results in very high strain in the construction, high surface pressures are generated and all this taken together results in the deflection of the pull rod.

Consequently, when producing industrial robots of the kind described above the need of a balancing arrangement arises, which can manage loads up to 250 kg and at the same time has as long expected life-time as the industrial robot. Thereby unwanted production interruptions and the need of spare parts is eliminated.

Those needs cannot be fulfilled by the balancing arrangement according to the above mentioned Japanese patent.

DESCRIPTION OF THE INVENTION

An industrial robot, comprising a manipulator with a control system, presents a robot foot, a stand and a robot arm with a wrist and a tool. The stand is pivotably arranged on the robot foot. The robot arm is pivotably arranged on the stand in a joint. The robot arm is composed of at least a first and a second arm part and also the wrist, all of which are pivotably arranged in relation to each other. A balancing arrangement is arranged to exert, when the robot is pivoted, a pulling force between a first and a second robot part and thereby to compensate for/balance the attraction of gravity when the relative position of the robot parts changes. The balancing arrangement is attached to the corresponding robot part with fastening devices.

The aim of the invention is to, arrange a helical spring based balancing arrangement on a robot as above, where the robot manages to lift 250 kg with its wrist without damaging the balancing arrangement. The aim of the invention is also to provide the robot with a balancing arrangement, which has as long life expectance as the robot. Consequently, the object of the invention is to improve, in a balancing arrangement according to above, the guiding of a pull rod in a spring housing and by that eliminate the risk of obliquity of the pull rod, the so-called drawer effect.

The solution according to the invention is characterized by the device specified in patent claim 1 with a balancing arrangement in the form of a helical spring based telescopic unit. A pull rod together with a guide tube form a telescopic unit., which is arranged between the robot parts and constitutes a support and a guide for the helical spring. When pivoting the robot the telescopic unit is extended or shortened at the same time as the guiding of the pull rod is improved in accordance with the independent method claim. Furthermore, the invention prevents that torque forces from the helical spring/springs spread to the telescopic unit, as the pull rod can pivot freely around its longitudinal axis, in accordance with the dependent claims. A robot according to the invention can be equipped with one or more balancing arrangements and preferably be arranged with a vertical robot arm in accordance with the independent utilization claim.

It is within the scope of the invention that the telescopic unit comprises more than two telescopic parts.

It is within the scope of the invention that the balancing arrangement according to the invention is arranged between arm parts in the robot, which are not directly connected.

5 It is within the scope of the invention that the robot is mounted in the ceiling or angularly mounted.

It is also within the scope of the invention that a robot is arranged in such a manner that the balancing arrangement is provided with spring seats, which are rigidly mounted on the respective attachments of the balancing arrangement, and that the telescopic unit extends
10 coaxially through the spring set. When pivoting the robot both the telescopic unit and the helical spring unit are longitudinally pulled out.

In the solution according to the invention is also included that the robot is provided with one or more balancing arrangements.

15

It is within the scope of the invention that the spring housing is provided with aerating holes to eliminate pumping effects from the movement of the piston back and forth.

20 It is within the scope of the invention that a ring fastener is rotatingly arranged through a roller bearing.

It is within the scope of the invention that the described piston is replaced by another type of spring seat.

25 It is within the scope of the invention that the pull rod is a piston rod.

DESCRIPTION OF THE DRAWINGS

The invention will be explained in detail through a description of an embodiment of the
30 invention in reference to the accompanying drawing, where

Fig 1 discloses a balancing arrangement according to the present invention with the pull rod retracted.

Fig 2 discloses a balancing arrangement according to fig 1 with the pull rod pulled out.

Fig 3 discloses a balancing arrangement according to fig 1 without a helical spring and pull rod.

Fig 4 discloses a guide ring arranged in a spring housing opening.

5 Fig 5 discloses an alternative embodiment of the invention.

Fig 6 discloses an industrial robot provided with a balancing arrangement according to the invention.

DESCRIPTION OF AN EMBODIMENT

10 An industrial robot 1 (fig 6) comprises a robot foot 2, a stand 3 pivotably arranged on the robot foot 2 and a robot arm 5 connected to a joint 4 on the stand 3, which robot arm 5 comprises a first and a second arm part 6 and 7, respectively. The robot arm 5 is pivoted around a horizontal axis 4a of rotation in the joint 4. A balancing arrangement 8, comprising a telescopic unit 9 and a helical spring unit 10, is mounted on the robot 1 (fig 1). The helical
15 spring unit 10 is coaxially arranged on the telescopic unit 9. The balancing arrangement 8 comprises in its first end 11 a first attachment 12 for pivoted mounting on the stand 3 and in its second end 13 a second attachment 14 for pivoted mounting on the first arm part 6.

The telescopic unit 9 comprises a first spring seat 15 and a second spring seat 16 between
20 which the helical spring unit 10 is arranged (fig 2). The first spring seat 15 comprises a spring housing 15a, which is arranged with a first end 17, a cylindrical envelope surface 18 and also a second end 19, provided with an opening 20. A mounting 12 in the form of a first ring fastener 21 is arranged on the outside of the first gable 17. The second spring seat 16 comprises a piston 22, which is rigidly arranged at the first end 23a of a pull rod 23. The pull
25 rod 23 together with the piston 22 are displaceably arranged inside the spring housing 15a. The tube-formed pull rod 23 extends from the piston 22, through a part of the spring housing 15a and out through the opening 20 in the second gable 19 of the spring housing 15a. The pull rod 23 is in its second end 23b provided with an attachment 14 in the form of a second ring fastener 24. The helical spring unit 10 comprises a spring set 25 in the form of two helical
30 springs 25a and 25b which are arranged inside the spring housing 15a between the piston 22 and the second gable 19 of the spring housing 15a.

When the pull rod is pulled out of the spring housing 15a the spring set 25 is compressed and thereby generates a spring force, which strives to extend the helical spring set and thus retract

the pull rod 23 back into the spring housing 15a. The generated spring force is used for the balancing.

Coaxially inside the spring housing 15a on the inside of the first gable 17 a guide-tube 26 is arranged. The guide tube 26 extends inside the spring housing 15a from the first gable 17 and almost to the second gable 19. The guide tube 26 thus has a length smaller than that of the spring housing 15a. The guide tube 26 has an outside diameter somewhat smaller than the inside diameter of the tube-formed pull rod 23.

When the pull rod 23 is displaced along the guide tube 26 the pull rod 23 will glide with very good guiding and minimal friction along the guide tube 26. This is accomplished by a first and a second bushing 27 and 28. The first bushing 27 is rigidly arranged coaxially with and on the inside of the pull rod 23 and of an opening 29 in the spring seat 22 to form a longitudinal continuous first guide surface 30 (fig 1). The second bushing 28 is rigidly arranged on the outside of the free end 31 of the guide tube 26, in order to form a longitudinal second guide surface 32 on the guide tube 26 (fig 3). When displacing the pull rod 23 the spring seat 22 slides along the guide tube 26

When the pull rod 23 is displaced through the opening 20 in the gable 19 it slides telescopically on the outside of the guide tube 26, which thus together form a telescopic unit 9. The movement is stabilized by the pull rod 23 being supported by the first 30 and the second 32 guide surfaces, which are arranged at a distance from each other longitudinally. The first 30 and the second 32 guide surfaces guide the pull rod 23 with a slip fit, which together with the guide tube 26 form a rigid unit 33 between the first 21 and the second 24 ring fasteners (fig 2).

A guide ring 34 is rigidly arranged in opening 20 of the second gable 19 of the spring housing 15a. The guide ring 34 is shaped with a third longitudinal guide surface 35 in the spring housing 15a. The third guide surface 35 guides and acts as a slide bearing to the pull rod 23 in its movement out of and into the spring housing 15a through the opening 20 (fig 2).

The possibility to compress the helical springs 25a and 25b arranged between the piston 22 and the second gable 19 of the spring housing 15a determines how far the pull rod 23 can be

pulled out from the spring housing 15a. From the figure 2 it is clear that the guide tube 26 and the pull rod 23 are telescopically arranged within each other in sufficient degree to provide exact guiding and a good stability when the pull rod 23 is maximally pulled out. To secure that the pull rod 23 can be freely pivoted in the spring housing 15a the second ring fastener 24
5 is rotatably arranged in the second end 23b of the pull rod 23 through an angular ball bearing 36.

The guide ring 34 is detachably mounted coaxially in the opening 20 of the gable 19 (fig 4). The function of the guide ring 34 is primarily to guide the pull rod 23 through the third guide
10 surface 35 and secondarily to seal or mark off the spring housing 15a. The guide ring 34 is easily replaceable. The guide ring 34 has an opening 37, which is slotted without material loss. It can thus easily be slipped on the pull rod 23 and guided axially to its intended position in the opening 20. A clamp ring 38 locks the guide ring 34 against axial displacement in the
15 opening 20.

PATENT CLAIMS

1. Industrial robot (1) comprising a first robot part (3) and a second robot part (5) movably
arranged relative each other and a balancing arrangement (8) operating between them,
5 where the balancing arrangement (8) comprises a first attachment (12) and a second
attachment (14) for an articulate fastening to the corresponding robot part (3, 6) and
where the balancing arrangement (8) is arranged to counteract the attraction of gravity
when the robot parts (3, 6) are pivoted, c h a r a c t e r i z e d in that the balancing
arrangement (8) comprises a telescopic unit (9) connected to the respective attachment
10 (12,14) and a helical spring unit (10) arranged between a first spring seat (15) and a
second spring seat (16) fixed on the telescopic unit (9).
2. Industrial robot according to claim 1, c h a r a c t e r i z e d in that the telescopic unit
(9) is arranged coaxially with the helical spring unit (10).
- 15 3. Industrial robot according to claims 1-2, c h a r a c t e r i z e d in that the telescopic
unit (9) comprises a pull rod (23) and a guide tube (26).
4. Industrial robot according to claim 3, c h a r a c t e r i z e d in that the guide tube (26)
20 comprises the first spring seat (15).
5. Industrial robot according to claim 3, c h a r a c t e r i z e d in that the pull rod (23)
comprises the second spring seat (16).
- 25 6. Industrial robot according to claims 1-4, c h a r a c t e r i z e d in that the first spring
seat (15) comprises a spring housing (15a).
7. Industrial robot according to claim 6, c h a r a c t e r i z e d in that the guide tube (26)
is fastened coaxially in the spring housing (15a) surrounding the helical spring unit (10).

8. Industrial robot according to claim 6, c h a r a c t e r i z e d in that the pull rod (23) is displaceably arranged on the exterior of the guide tube (26) and extends with a first end (23a) out through an opening (20) in the spring housing (15a).

5 9. Industrial robot according to claim 3, c h a r a c t e r i z e d in that the pull rod (23) is designed with a freely rotatably attachment (12) in its second end (23b).

10. Industrial robot according to claim 8, c h a r a c t e r i z e d in that an exchangeable guide ring (34) is rigidly arranged in the opening (20) of the spring housing (15a).

10

11. Method of balancing an industrial robot (1) comprising a first robot part (3) and a second robot part (6) movably arranged relative each other and a balancing arrangement (8) operating between them, where the balancing arrangement (8) comprises a first attachment (12) and a second attachment (14) for an articulate fastening to the
15 corresponding robot part (3, 6) and where the balancing arrangement is arranged to counteract the attraction of gravity when the robot parts (3, 6) are pivoted, c h a r a c t e r i z e d in that the balancing arrangement (8) is made to include a telescopic unit (9) connecting to the respective attachment (12, 14) and that a helical spring unit (10) is arranged between a first spring seat (15) fixed on the telescopic unit
20 and a second spring seat (16).

12. Method for an industrial robot according to claim 11, c h a r a c t e r i z e d in that the telescopic unit (9) guides the helical spring unit (10).

25 13. Method for an industrial robot according to one of the claims 11-12 c h a r a c t e r i z e d in that the helical spring unit (10) is arranged coaxially on the telescopic unit (9).

14. Method according to claim 11 c h a r a c t e r i z e d in that the second attachment
30 (14) is applied in the form of a freely rotatable ring fastener (24).

15. Use of a robot according to claim 1 and a method according to claim 11 arranged with a vertically articulated robot arm.

1/5

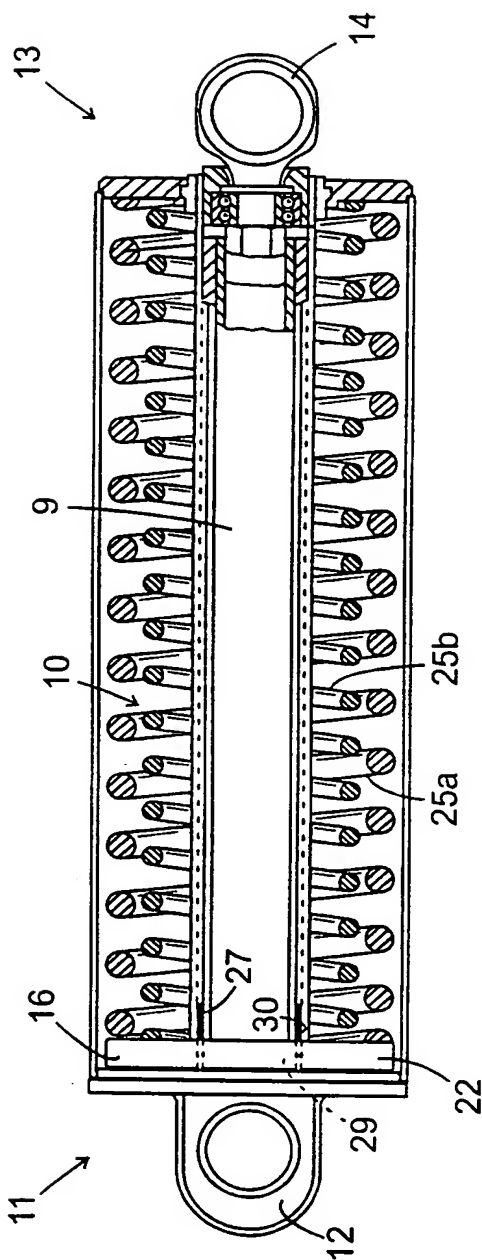
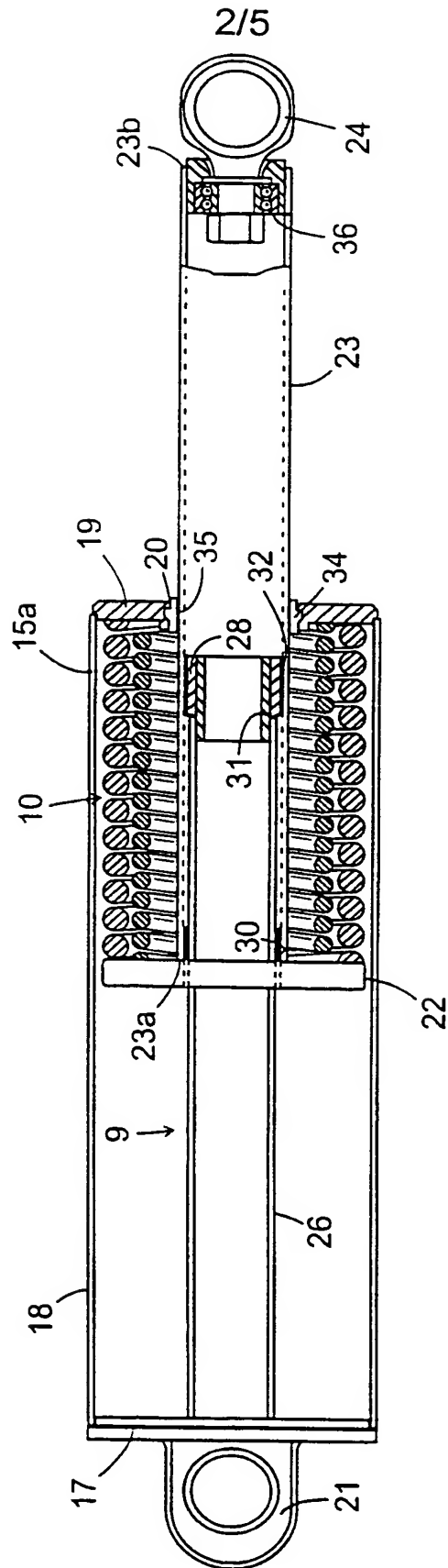


FIG.1



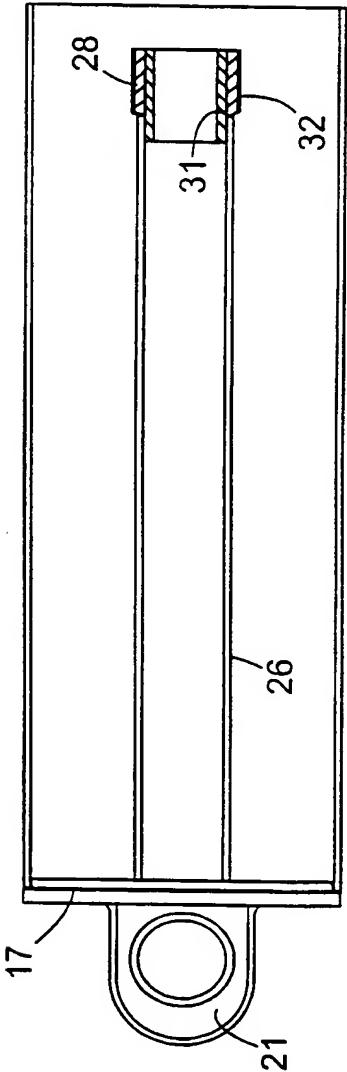


FIG.3

4/5

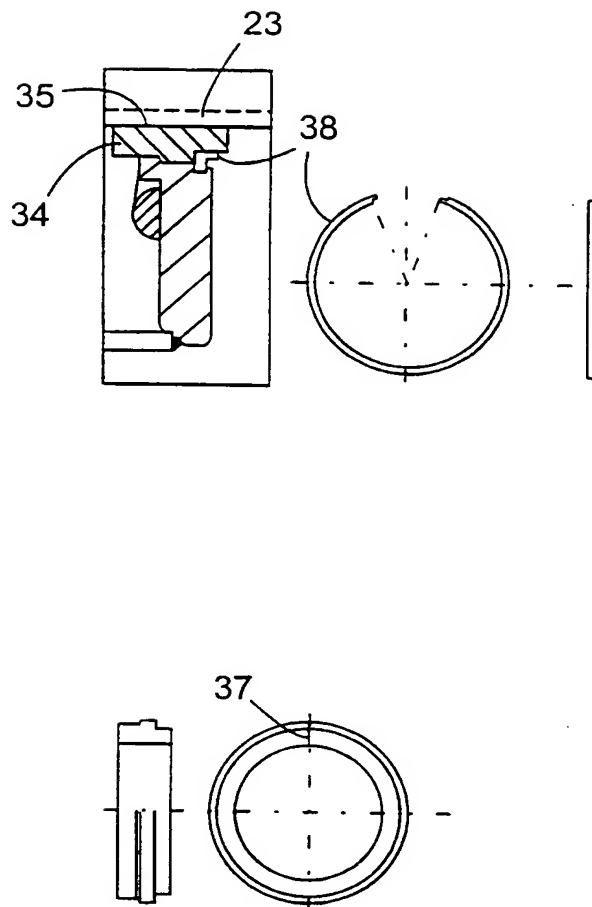


FIG.4

5/5

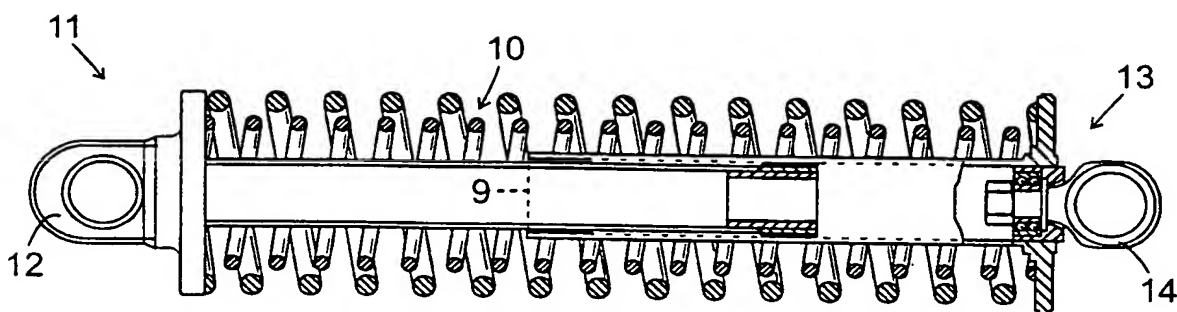


FIG. 5

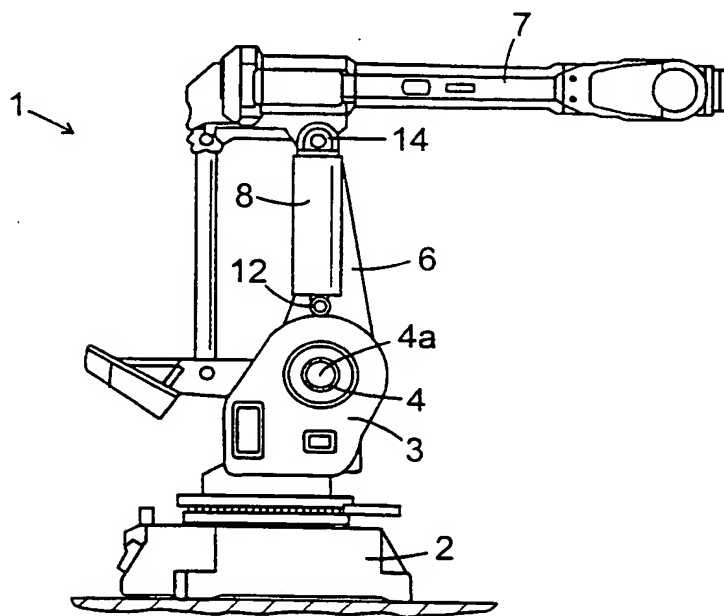


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 00/02469

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B25J 19/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B25J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0947296 A2 (FANUC LTD.), 6 October 1999 (06.10.99), column 1, line 30 - line 43; column 6, line 10 - line 19, figures 1,3 --	1-15
A	JP 10225891 A(NACHI FUJIKOSHI CORP) 1998-08-25 (abstract)World Patents Index (online).London, U.K.: Derwent Publications Ltd. (retrieved on 2001 -03-06). Retrieved from EPO WPI Database.DW199844, Accession No.1998-514423; & JP 10225891 /NACHI FUJIKOSHI CORP) 1998-11-30 (abstract).(online)(retrieved on 2001-03-06) Retrieved from :EPO PAJ Database; JP 10225891 A (NASHI FUJIKOSHI CORP) 25 August 1998,fig 1a,1b abstract. --	1-15

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"I" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

6 March 2001

Date of mailing of the international search report

22-03-2001

Name and mailing address of the ISA/

Swedish Patent Office

Box 5055, S-102 42 STOCKHOLM

Facsimile No. +46 8 666 02 86

Authorized officer

Ender Dag /itw

Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 00/02469

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4592697 A (GORO TUA ET AL), 3 June 1986 (03.06.86), figure 4, abstract -- -----	1-15